NTH Consultants, Ltd.
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Arnold E. Leder
USEPA Region V
77 West Jackson Boulevard
Chicago, Il 60604-3590

July 2, 2004
Proj. No. 13-020064-20

RE: Walnutdale Farms
Volume Calculations

Dear Mr. Leder:

We have completed the design volume calculations for the new storm water storage structure. The following details our design process and the attached documents our calculations.

We have analyzed the sub-watersheds that contribute runoff to the northwest corner of the farm. This analysis differs from May and Associates' based on clean water diversions that will be implemented.

Sub-watershed Delineation

The sub-watersheds are represented on the attached map and described below.

- Sub-watershed A
  - The areas that contribute runoff to catch basins AA, X, Y, and Z.
  - A collection header will be installed north of barns G-6, G-7, and G-8A. The header will connect to the outlets from catch basins AA and Y, and connect them to the storage structure.

- Sub-watershed B
  - The area east of Pit 5 and Pit 6, the actual silage storage area, was previously delineated as area contributing to the storage needs of the existing storage structure to the east. Nonetheless, this area will be counted again; as contributing to runoff for the new structure.

- The existing water collection area/Solids Trap west of the silage pad will be lined with concrete so that it may be used as a reception/pump-out pit, continue to be used to filter solids, and the solids can be more readily removed.
- The cattle walkway connecting the west side of the Freshing Barn to the west end of Pit 6 will be diverted into the solids trap.

- Sub-watershed C
  - The drain from catch basin FF follows the perimeter of the milking parlor along the west side and collects the water in that general area shown.
  - The remaining clean water will be diverted away from the storage structure and/or transfer components.

- Sub-watershed D collects the area shown and eventually flows into the solids trap (Sub-watershed B).

Storm Water Modeling

We used the HEC-HMS 2.2.2 (HEC) model to calculate the 25-year, 24-hour storm water storage requirement and maximum flow rate from the solids trap, Sub-watershed A, and Sub-watershed C. Information provided by May and Associates' survey was used to enter detailed information about the conveyances in the model. The storage requirements for the 25-year, 24-hour storm are 440,000 gallons (59,000 ft^3). A summary outlining the peak discharge, total runoff volume, and drainage area for each sub-watershed is attached in Appendix A.

Storage Sizing

Animal Waste Management 2.0.2 (AWM) software was used to determine seasonal six-month storage requirement. The Michigan climate data for Allegan County in AWM was used to calculate the six-month storage requirement and the precipitation minus evaporation for November to April. The storage requirement for the average six-month runoff is 1.5 million

gallons (198,000 ft^3). Output from AWM and our calculations for precipitation minus evaporation are attached in Appendix B. It should be noted that we are using AWM only as a design tool to determine six months of runoff based on the areas delineated on the attached map and for precipitation minus evaporation data. Therefore, the surface area of this structure is not indicative of the actual design.

Storage Requirements

Assuming a length and width of 300 ft by 200 ft (60,000 ft^2 surface area) and a depth of 6.5 ft, our preliminary determination for total six-month storage is 3 million gallons (390,000 ft^3). It should be recognized that depending on the subsurface investigation the depth which effects the surface area, (which affects the volume requirements for the direct precipitation and ultimately effects the total volume) is subject to change. Calculations are included in Appendix C.

Two copies have been provided for additional review. If you have any questions or comments, please feel free to call me at (616) 957-3690.

Sincerely,
NTH Consultants, Ltd.

Timothy C. Krause, EIT
Senior Staff Engineer

Marc E. Groenleer, P.E.
Senior Project Engineer,
Project Manager

cc: Kevin Lettinga, Walnutdale Farms

Attachments

HMS * Summary of Results

Project : Walnutdale Run Name : Run 5

Start of Run : 16Jun04 0800 Basin Model : Farmstead2
End of Run : 17Jun04 1400 Met. Model : Farmstead Met
Execution Time : 23Jun04 1229 Control Specs : Farmstead Control

Hydrologic Element	Discharge Peak (cfs)	Time of Peak	Volume (ac ft)	Drainage Area (sq mi)
Catch Basin Z	0.34902	16 Jun 04 2028	0.058669	0.000
CB Z Conveyance	0.34892	16 Jun 04 2028	0.058669	0.000
Catch Basin AA	0.60378	16 Jun 04 2046	0.13492	0.001
Basin AA	0.90656	16 Jun 04 2038	0.19359	0.001
CB AA Conveyance	0.90653	16 Jun 04 2038	0.19359	0.001
Catch Basin X	0.30827	16 Jun 04 2003	0.024855	0.000
CB X Conveyance	0.30750	16 Jun 04 2003	0.024855	0.000
Catch Basin Y	0.60574	16 Jun 04 2037	0.11799	0.001
Basin Y	0.64548	16 Jun 04 2035	0.14284	0.001
CB Y Conveyance	0.64535	16 Jun 04 2036	0.14285	0.001
Subwatershed A	1.5507	16 Jun 04 2037	0.33643	0.001
A Conveyance	1.5507	16 Jun 04 2037	0.33643	0.001
Trap Shed	1.1056	16 Jun 04 2244	0.56981	0.002
[illegible]p Shed	0.44971	16 Jun 04 2042	0.088353	0.000
[illegible]tle Walkway Shed	0.15012	16 Jun 04 2048	0.034247	0.000
Subwatershed B	1.2069	16 Jun 04 2228	0.69241	0.003
B Conveyance	1.2069	16 Jun 04 2228	0.69241	0.003
Subwatershed D	0.98096	16 Jun 04 2051	0.22533	0.001
D Conveyance	0.98080	16 Jun 04 2051	0.22533	0.001
Solid Trap	2.0329	16 Jun 04 2055	0.91773	0.004
Trap Conveyance	2.0328	16 Jun 04 2055	0.91772	0.004
Subwatershed C	1.0592	16 Jun 04 2006	0.090543	0.000
C Conveyance	1.0582	16 Jun 04 2006	0.090547	0.000
Storage Structure	3.6160	16 Jun 04 2043	1.3447	0.006

$\times 43560$

$= 58,575 ft^3$

Animal Waste Management Plan
prepared for Walnutdale Farms

Designed By: Pete Wyckoff Checked By: _____

Date: 06/22/2004 Date: _____

Farm Information

Data Source: NRCS

# of Operating Periods: 1

Operating Period: January - December

Climate Data

State: MI

County: Allegan

Station: ALLEGAN MI0128

ear - 24 Hour Storm Event: 4.5 inches

Month	Prec. (in)	Evap. (in)
January	2.21	0.25
February	1.67	0.50
March	2.48	1.51
April	3.53	2.27
May	3.14	2.77
June	3.56	3.53
July	3.39	4.79
August	3.33	4.54
September	3.64	3.02
October	2.96	1.26
November	3.03	0.50
December	2.78	0.25
Totals	35.72	25.19

Lagoon Loadings:

Rational Design Method

Barth KVAL: 0

Load Rate For Odor, OCV: 0 lbs VS/cu. ft/day

LRV Max: 0.00625 lbs VS/cu. ft/day

NRCS Design Method

Anaerobic Load Rate: 0 lbs VS/1000 cu. ft/day

Runoff

R ff Volume Method: Calculate Monthly Runoff Volumes with AWM

Pervious Watershed Area: 0.794995 acres

Pervious Curve Number Storm: 97

Pervious Curve Number Monthly: 87.95755 (1 day), 73 (30 day)

Impervious Area: 128772 sq. ft

Runoff Volumes (1000 cu. ft.)

	Pervious	Impervious	Monthly Totals
January	1.20	18.16	19.36
February	0.53	12.65	13.18
March	1.59	20.96	22.55
April	3.44	31.96	35.40
May	2.71	27.85	30.56
June	3.50	32.28	35.78
July	3.17	30.48	33.65
A ust	3.06	29.85	32.91
S ember	3.66	33.12	36.78
October	2.39	25.97	28.36
November	2.51	26.70	29.21
December	2.08	24.08	26.16
Total	29.84	314.06	343.90

25 Yr-24 Hr Storm	11.97	45.76	57.73

Waste Facilities

rage Pond #1

Design Dimensions

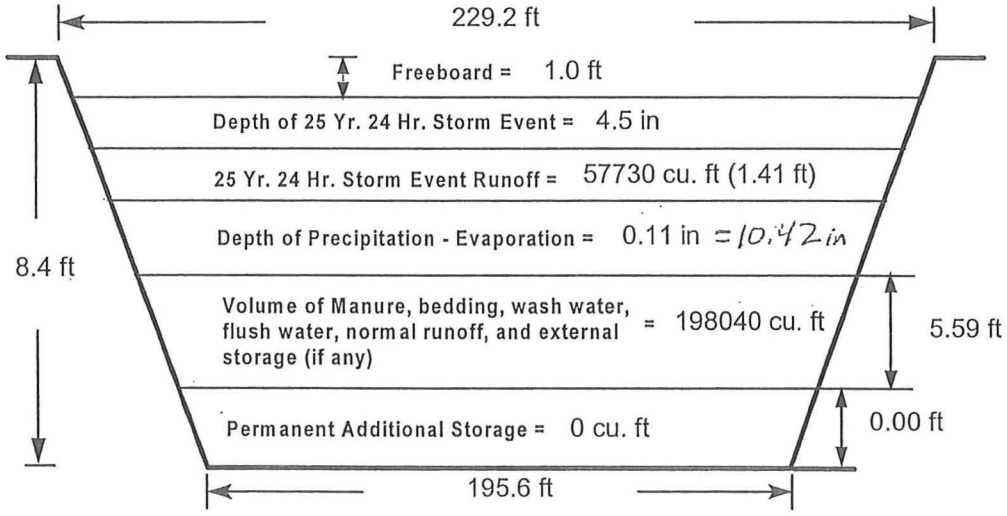
Shape:	Rectangle
Top Dimensions:	193.5 ft x 229.2 ft
Bot Dimensions:	160.0 ft x 195.6 ft
Sideslope:	2:1
Storage Depth:	7.0 ft
Final Depth:	8.4 ft
Freeboard:	1.0 ft

Design Quantities

Depth of 25 Yr. Storm:	4.5 in
Depth of Precip Minus Evap:	0.1 in
Waste Volume:	198040 cu. ft
Permanent Add'l Storage:	0 cu. ft

Water Budget (1000 cu. ft)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Withdrawal Months				X						X			
Waste Volume	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Runoff	19.36	13.18	22.55	35.40	30.56	35.78	33.65	32.91	36.78	28.36	29.21	26.16	343.90
-Evap	7.24	4.32	3.58	4.66	1.37	0.11	-5.17	-4.47	2.29	6.28	9.35	9.35	
Cum. Storage Vol	100.67	118.18	144.31	184.37	31.93	67.82	96.29	124.73	163.80	198.45	38.56	74.07	



	Precip	Evap	Difference
May	3.14	2.77	0.37
June	3.56	3.53	0.03
July	3.39	4.79	-1.4
August	3.33	4.54	-1.21
Sept	3.64	3.02	0.62
Oct	2.96	1.26	1.7
Nov	3.03	0.5	2.53
Dec	2.78	0.25	2.53
Jan	2.21	0.25	1.96
Feb	1.67	0.5	1.17
March	2.48	1.51	0.97
April	3.53	2.27	1.26
Totals	35.72	25.19	10.53

Season	Difference
Summer	0.11
Winter	10.42

Input data from the Animal Waste Management Plan model.

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Farmington Hills, MI	248.553.6300
Exton, PA	610.524.2300
Detroit, MI	313.965.0036
Lansing, MI	517.321.6900
Grand Rapids, MI	616.957.3690
Pontiac, MI	248.745.6401

Job Walnutdale | Project No. 13-020064-20 | Sheet No. 1

Subject Storm Water Storage Pond | By Pete Wyckoff | Date 6/17/04

Checked By | Date

Unknown: Total storage volume required for to design Storm Water storage pond.

Given: 25 year 24hour storm = 4.45 in.
Run Runoff volume produced from 25year/24hour storm = 58575 ft^3 (HEC-HMS model)
Volume from 6 months of runoff (Nov-April) = 198040 ft^3 (AWM model)
Depth of Precipitation^{evap} = 10.42 in (AWM Model)
freeboard = 1ft

Assume: Top dimensions 195ft x 230ft
Vertical Side Walls

Calculations:

Area = wxL = 195' x 230' = 44850 ft^2

Direct rainfall contribution = (Precip-evap)* Area = $\frac{10.42\,in}{12\,in/ft}$ x 44850 ft^2
= 38944.75 ft^3

Direct contribution from 25 year/24hour storm = Precip (in) x Area (ft^2)
= $\left(\frac{4.45\,in}{12\,in/ft}\right)$ x 44850 ft^2 = 16631.875 ft^3

Freeboard = 1ft x Area = 1' x 44850 ft^2 = 44850 ft^3

Total volume = (Cumulative direct rainfall contribution) + (Direct rainfall from (25yr/24hr) storm)
+ (Freeboard) + (Runoff volume from 25yr/24hr storm)
+ Cumulative runoff volume during winter (Nov-April)

Total Volume = 38944.75 ft^3 + 16631.88 ft^3 + 44850 ft^3 + 58575 ft^3 + 198040 ft^3
= 357041 ft^3 or 2,670,860 gallons

Depth = Volume/Area = $\frac{357041}{44850}$ = 8ft

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Job Walnut Lake | Project No. 13-020064-20 | Sheet No. 2
Subject Storm Water Storage Pond | By PCW | Date 6/17/04
Checked By | Date

Redesign Depth = 7 ft
Width = 200 ft
Length = ?

Volume = 357042 ft^3

$$\text{Length} = \frac{357042}{(7)(200)} = 255 \text{ ft}$$

Area = 200' x 255' = 51,000 ft^2

Redesign Depth = 6 ft
Width = 200 ft
Length = ?
Volume = 357042 ft^3

$$\text{Length} = \frac{357042}{(6)(200)} = 298 \text{ ft} \sim 300 \text{ ft}$$

Area = 200' x 300' = 60000 ft^2

Based on calculated areas, 6 soil borings are required during the subsurface investigation.

Required Volume for 200' x 300'

$$\text{Direct Precipitation} = \left(\frac{10.42''}{12 \text{ in/ft}}\right)(60{,}000 \text{ ft}^2) = 52100 \text{ ft}^3$$

Direct contribution from 25-year/24 hour storm

$$= \frac{4.45''}{12 \text{ in/ft}} (60{,}000 \text{ ft}^2) = 22{,}250 \text{ ft}^3$$

Freeboard = 1' x 60,000 ft^2 = 60,000 ft^3

Total Volume: 52,100 ft^3 + 22,250 ft^3 + 60,000 ft^3 + 585754 ft^3 198040 ft^3

= 390,960 ft^3 = 2924,621 gal

Required Depth = 6.52'